MARSSIM Revision 2 Charge Discussion

SCIENCE ADVISORY BOARD

RADIATION ADVISORY COMMITTEE

JANUARY 11-14, 2021

Charge Discussion

Charge Question #1 (1.1-1.5)

Charge Question #2 (2.1-2.3)

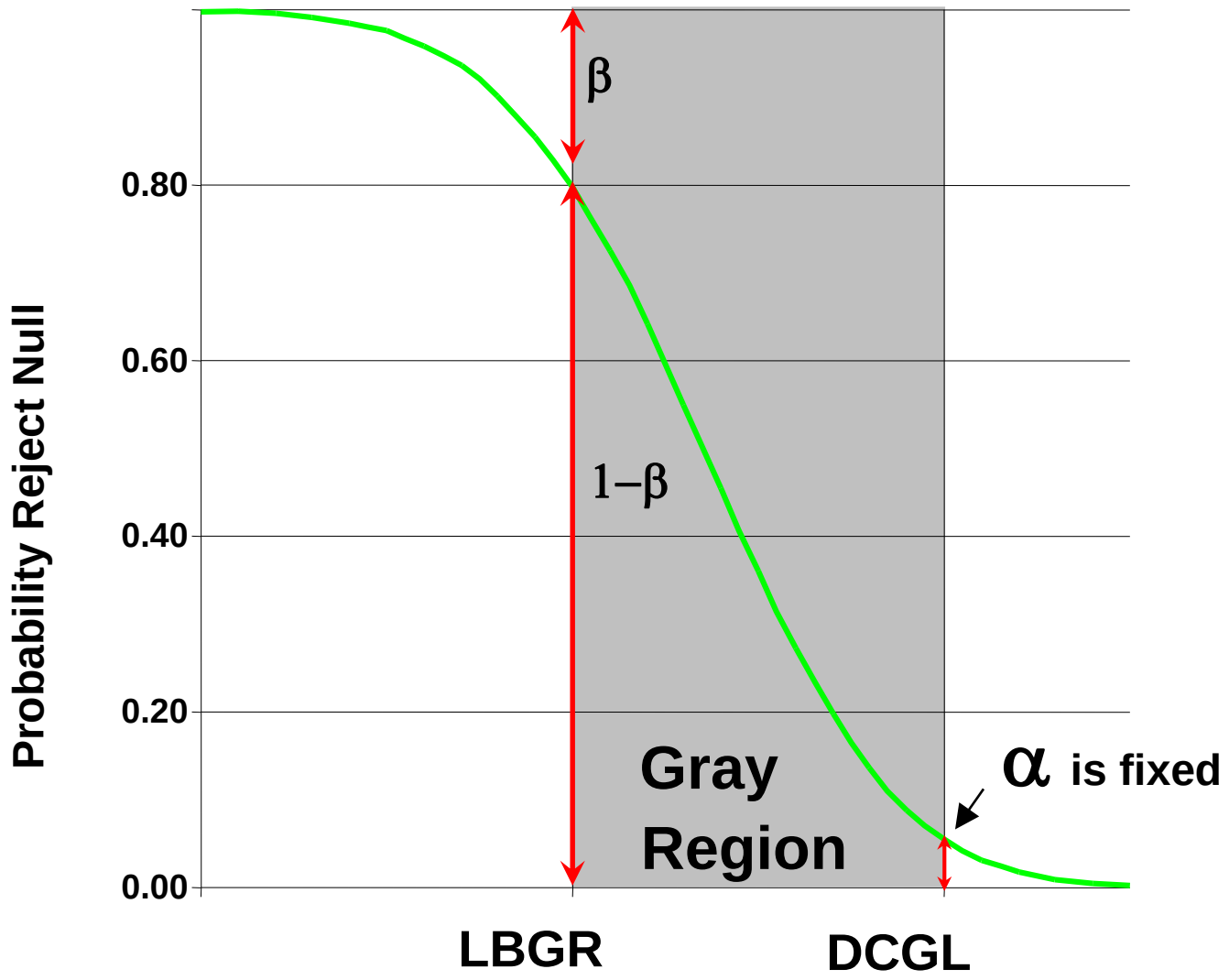
Charge Question #3 (3.1-3.4)

Charge Question 1.1

Scan-Only Surveys

Charge Question 1.2

Scenario B



Charge Question 1.3 – Part 1

MQOs – Measurement Method Uncertainty

$$u_c^2(y) = \sum_{i=1}^{N} \left(\frac{\partial f}{\partial x_i} \right)^2 u^2(x_i) = \sum_{i=1}^{N} c_i^2 u^2(x_i)$$

Charge Question 1.3 – Part 2

MQOs – Measurement Detectability and Measurement Quantifiability

"A common practice in the past has been to select a measurement method based on the minimum detectable concentration (MDC), which is defined in Section 7.5. For example, MARSSIM (2002) says:

During survey design, it is generally considered good practice to select a measurement system with an MDC between 10-50% of the DCGL [action level].

Such guidance implicitly recognizes that for cases when the decision to be made concerns the mean of a population that is represented by multiple measurements, criteria based on the MDC may not be sufficient and a somewhat more stringent requirement is needed. The requirement that the MDC (approximately 3-5 times σ_M) be 10% to 50% of the action level is tantamount to requiring that σ_M be 0.02 to 0.17 times the action level – in other words, the relative standard deviation should be approximately 10% at the action level. However, the concentration at which the relative standard deviation is 10% is the MQC when k_Q assumes its conventional value of 10."

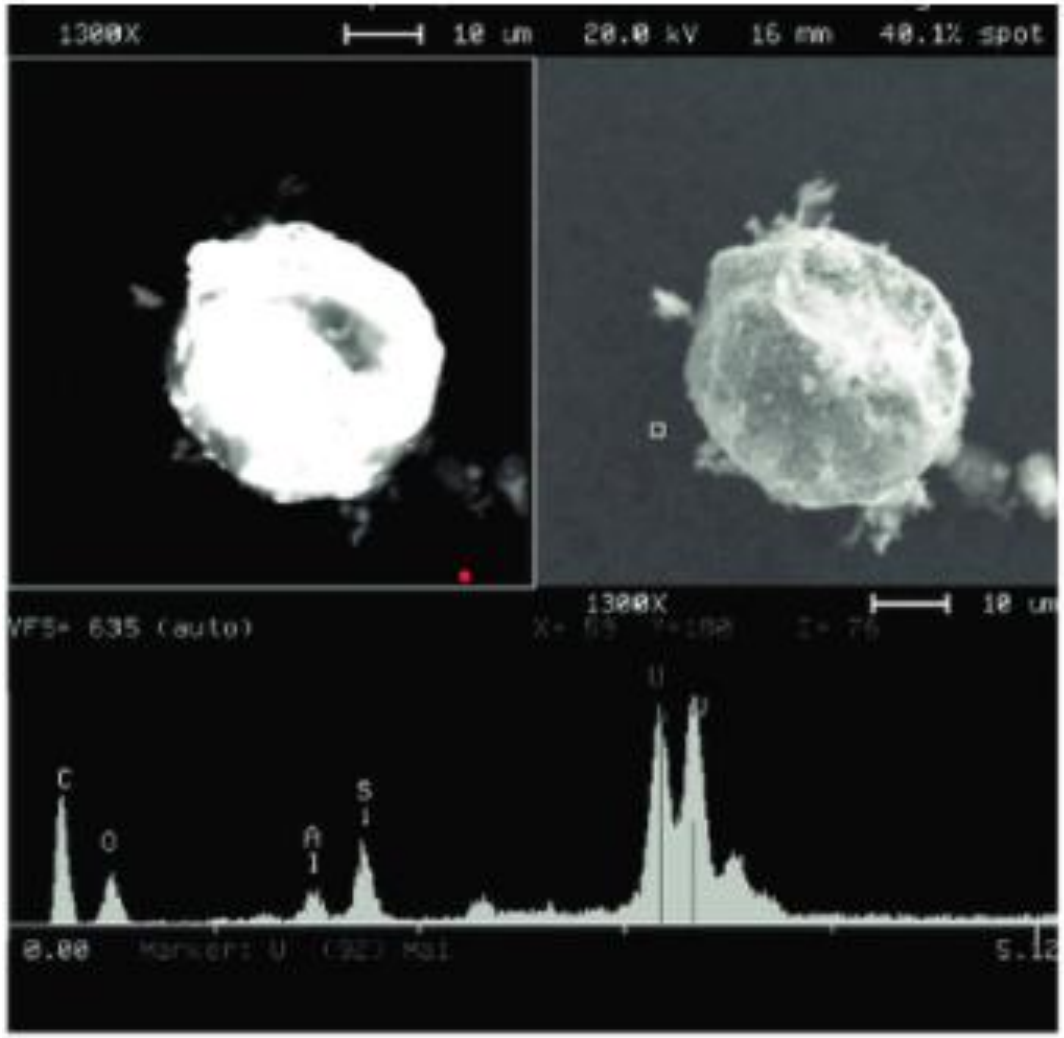
Charge Question 1.4

Areas of Elevated Concentration

$$\frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \cdots + \frac{C_i}{DCGL_i} + \cdots + \frac{C_n}{DCGL_n} \leq 1$$

Charge Question 1.5

Discrete Radioactive Particles

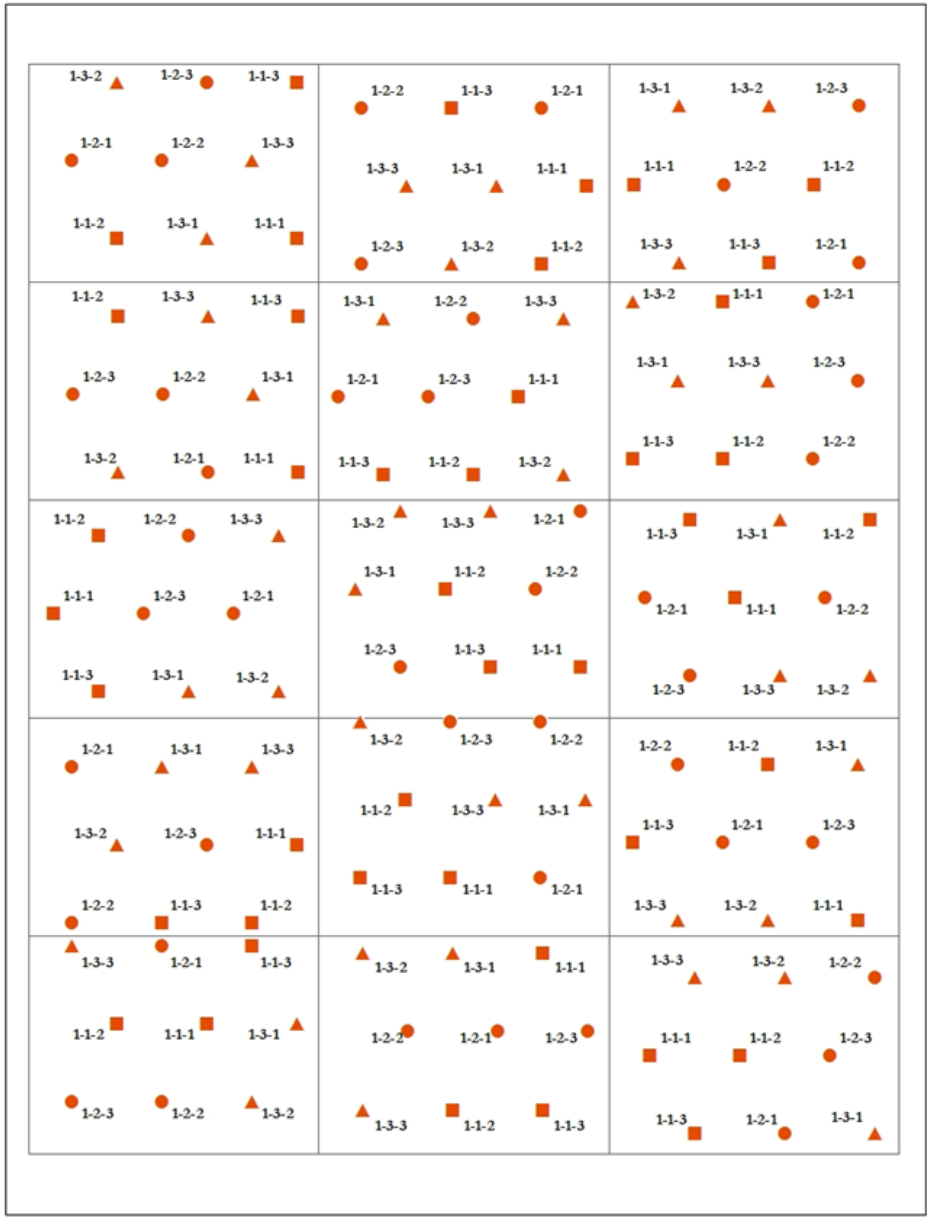


Charge Question 2.1

Updated Instrumentation

Charge Question 2.2

Ranked Set Sampling



Charge Question 2.3

Added Examples

Example 5: Use of WRS Test under Scenario B

A site has 14 survey units and 1 reference area in a building, and the same measurement method is used to perform measurements in each survey unit and the reference area. The radionuclide is present in background at a level of 100 ± 15 becquerels/meter squared (Bq/m^2) (1σ). The standard deviation of the radionuclide in the survey area is 40 Bq/m^2, based on previous survey results for the same or similar radionuclide distribution. When the estimated standard deviation in the reference area and the survey units are different, the larger value, 40 Bq/m^2 in this example, should be used to calculate the relative shift. During the Data Quality Objective process, Scenario B is selected because the release criterion for the site is no residual radioactive material above background. The discrimination limit is selected to be 220 Bq/m^2 as a stakeholder agreed-upon starting point for developing an acceptable survey design, and Type I and Type II error values (α and β) of 0.05 are selected. Determine the number of data points to be obtained from the reference area and from each of the survey units for the statistical tests.

The value of the relative shift for the reference area, Δ/σ, is $(220 - 100)/40$, or 3.0. The number of data points can be obtained directly from **Table 5.2.** For $\alpha = 0.05$, $\beta = 0.05$, and $\Delta/\sigma = 3.0$, a value of 10 is obtained for $N/2$. The table value has already been increased by 20 percent to account for missing or unusable data.

Charge Question 3.1

Lower Bound of the Gray Region

lower bound of the gray region (LBGR): The *radionuclide concentration* or level of *radioactivity* that corresponds with the lowest value in the range where the consequence of decision errors is relatively minor. For *Scenario A*, the *LBGR* is chosen to represent a conservative estimate of the concentration of residual radioactive material.

Charge Question 3.2

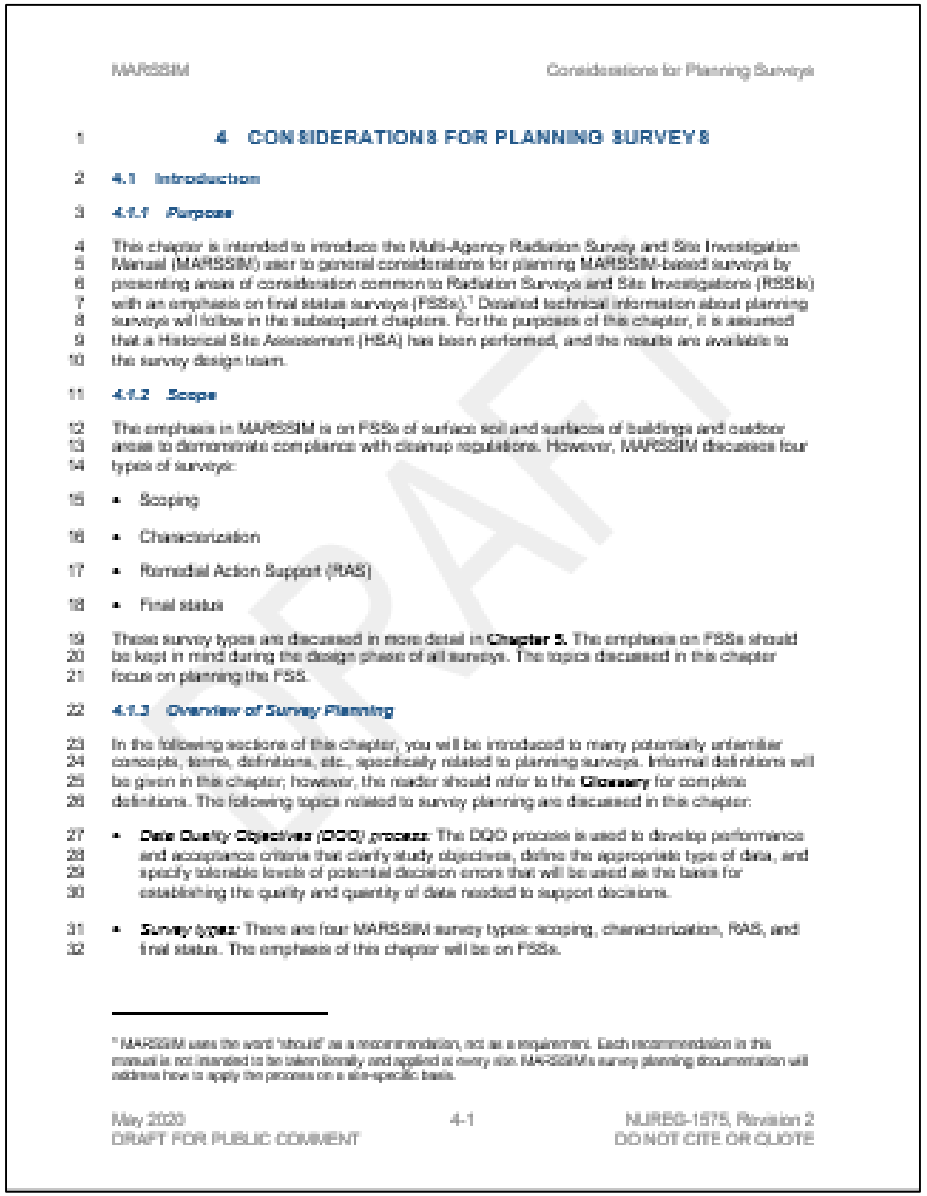
Area Factors

Table O.4: Illustrative Examples of Outdoor Area Factors[6]

Nuclide	Area (m^2)								
	1	3	10	30	100	300	1,000	3,000	10,000
^{241}Am	120	42	14	5.1	1.8	1.2	1.0	1.0	1.0
^{60}Co	9.7	4.4	2.1	1.5	1.2	1.1	1.1	1.0	1.0
^{137}Cs	11	4.9	2.4	1.8	1.4	1.2	1.1	1.1	1.0
^{63}Ni	1600	540	190	56	17	5.6	1.7	1.5	1.0
^{226}Ra & progeny w/radon	60	23	8.5	3.4	1.2	1.1	1.0	1.0	1.0
^{226}Ra & progeny, w/o radon	25	11	5.3	3.6	2.7	1.9	1.0	1.0	1.0
^{232}Th & progeny	19	8.6	4.2	3.0	2.2	1.6	1.0	1.0	1.0
^{238}U	89	41	21	15	11	4.4	1.3	1.0	1.0

Charge Question 3.3

Chapter 4 Reorganization



4 CONSIDERATIONS FOR PLANNING SURVEYS

4.1 Introduction

4.1.1 Purpose

This chapter is intended to introduce the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) user to general considerations for planning MARSSIM-based surveys by presenting areas of consideration common to Radiation Surveys and Site Investigations (RSSIs) with an emphasis on final status surveys (FSSs).[1] Detailed technical information about planning surveys will follow in the subsequent chapters. For the purposes of this chapter, it is assumed that a Historical Site Assessment (HSA) has been performed, and the results are available to the survey design team.

4.1.2 Scope

The emphasis in MARSSIM is on FSSs of surface soil and surfaces of buildings and outdoor areas to demonstrate compliance with cleanup regulations. However, MARSSIM discusses four types of surveys:

- Scoping
- Characterization
- Remedial Action Support (RAS)
- Final status

These survey types are discussed in more detail in **Chapter 5.** The emphasis on FSSs should be kept in mind during the design phase of all surveys. The topics discussed in this chapter focus on planning the FSS.

4.1.3 Overview of Survey Planning

In the following sections of this chapter, you will be introduced to many potentially unfamiliar concepts, terms, definitions, etc., specifically related to planning surveys. Informal definitions will be given in this chapter; however, the reader should refer to the **Glossary** for complete definitions. The following topics related to survey planning are discussed in this chapter:

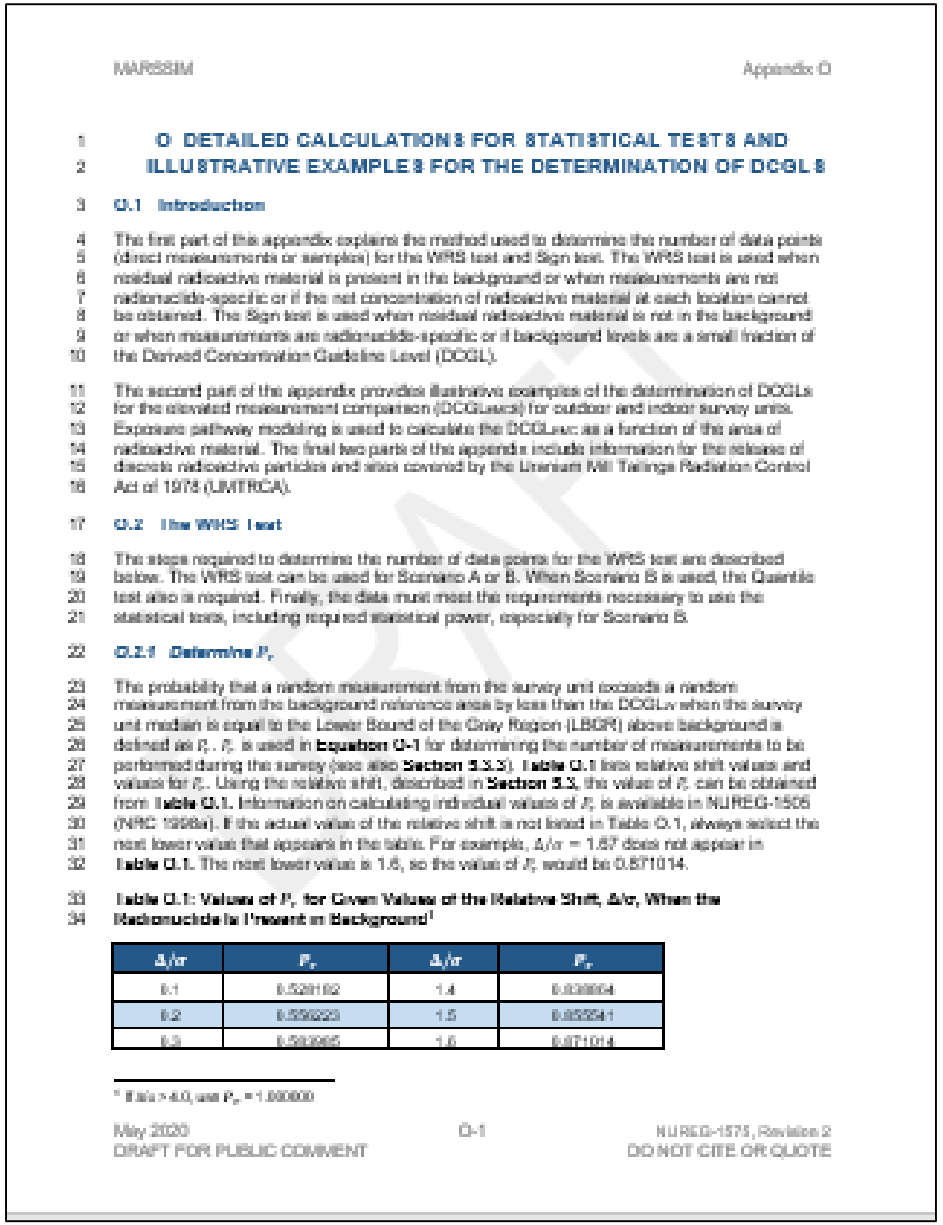
- ***Data Quality Objectives (DQO) process:*** The DQO process is used to develop performance and acceptance criteria that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

- ***Survey types:*** There are four MARSSIM survey types: scoping, characterization, RAS, and final status. The emphasis of this chapter will be on FSSs.

[1] MARSSIM uses the word 'should' as a recommendation, not as a requirement. Each recommendation in this manual is not intended to be taken literally and applied at every site. MARSSIM's survey planning documentation will address how to apply the process on a site-specific basis.

Charge Question 3.4

Appendix O



O DETAILED CALCULATIONS FOR STATISTICAL TESTS AND ILLUSTRATIVE EXAMPLES FOR THE DETERMINATION OF DCGLS

O.1 Introduction

The first part of this appendix explains the method used to determine the number of data points (direct measurements or samples) for the WRS test and Sign test. The WRS test is used when residual radioactive material is present in the background or when measurements are not radionuclide-specific or if the net concentration of radioactive material at each location cannot be obtained. The Sign test is used when residual radioactive material is not in the background or when measurements are radionuclide-specific or if background levels are a small fraction of the Derived Concentration Guideline Level (DCGL).

The second part of the appendix provides illustrative examples of the determination of DCGLs for the elevated measurement comparison (DCGL$_{EMC}$) for outdoor and indoor survey units. Exposure pathway modeling is used to calculate the DCGL$_{EMC}$ as a function of the area of radioactive material. The final two parts of the appendix include information for the release of discrete radioactive particles and also covered by the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA).

O.2 The WRS Test

The steps required to determine the number of data points for the WRS test are described below. The WRS test can be used for Scenario A or B. When Scenario B is used, the Quantile test also is required. Finally, the data must meet the requirements necessary to use the statistical tests, including required statistical power, especially for Scenario B.

O.2.1 Determine P_r

The probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the DCGL$_W$ when the survey unit median is equal to the Lower Bound of the Gray Region (LBGR) above background is defined as P_r. P_r is used in **Equation O-1** for determining the number of measurements to be performed during the survey (see also **Section 5.5.2.1**). **Table O.1** lists relative shift values and values for P_r. Using the relative shift, described in **Section 5.3**, the value of P_r can be obtained from **Table O.1**. Information on calculating individual values of P_r is available in NUREG-1505 (NRC 1998a). If the actual value of the relative shift is not listed in Table O.1, always select the next lower value that appears in the table. For example, $\Delta/\sigma = 1.67$ does not appear in **Table O.1**. The next lower value is 1.6, so the value of P_r would be 0.871014.

Table O.1: Values of P_r for Given Values of the Relative Shift, Δ/σ, When the Radionuclide Is Present in Background[1]

Δ/σ	P_r	Δ/σ	P_r
0.1	0.520102	1.4	0.839804
0.2	0.539223	1.5	0.855241
0.3	0.558265	1.6	0.871014

[1] If $\Delta/\sigma > 4.0$, use $P_r = 1.000000$

Questions